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DESCRIPTION OF GLOCHIDIA OF THREE SPECIES OF FRESHWATER MUSSELS (UNIONIDAE) FROM SOUTHEASTERN TURKEY

Hülya Şereflişan[1]*, Menderes Şereflişan[1] & Soner Soylu[2]

INTRODUCTION

Unionoidean larvae have a short parasitic phase on fish scales, fins, or gills (Mansur & Silva, 1999). Within in the family Unionidae, glochidia are classified as subcircular unhooked, subtriangular hooked with spinules, subtriangular hooked without spinules, or axeheaded (Graf & Cumming, 2006).

The glochidial stage of *Unio terminalis* Bourguignat, 1852, from the northeast Mediterranean region, has not been described previously. This species is an important component of the macrobiota of the inland waters of the region and the most abundant unionid in Gölbaşı Lake, Hatay Province, Turkey (Şereflişan, 2003). *Potomida littoralis* (Cuvier, 1798) is the second most abundant species, and *Anodonta pseudodopsis* Locard, 1883, is the least abundant species in this lake. These species can be diagnosed at the juvenile stage, but the glochidia of *Unio terminalis* and *Anodonta pseudodopsis* are difficult to distinguish.

The glochidial morphology and measurements based on light microscopy were described by Engel & Wächtler (1989) and other researchers. Using scanning electron microscopy (SEM), glochidial shells of family Unionidae were studied by Hoggarth (1999) and other researchers. Taxonomic and geographical diversity of the Unionidae were examined by Graf & Cumming (2006). Certain reproductive characteristics of *Unio terminalis* were reported by Çek & Şereflişan (2006), and the periods of gravidity were reported by Şereflişan (2003).

With the use of scanning electron microscopy, minute glochidial structures can be examined and used to interpret relationships among unionid species. This paper describes the glochidia of the northeast Mediterranean mussels *P. littoralis, A. pseudodopsis*, and *U. terminalis*.

MATERIALS AND METHODS

Gravid female *P. littoralis*, *A. pseudodopsis,* and *U. terminalis* were dredged from 0.5–2 m in Gölbaşı Lake, Hatay, Turkey (36°30'16"N; 36°29'42"E) from September 2003 to June 2004. Some specimens were also retrieved from 5–6 m by SCUBA diving. Samples were transported live to the laboratory in cool boxes and kept in aquarium conditions for 1 week.

Mature glochidial larvae were released by squeezing the marsupial gills in charcoal-filtered tap water. The larvae were washed several times with water. Whole glochidia were placed open on a slide and examined and photographed both fresh and after being fixed and stained.

In order to stain the preparations samples of each species were first fixed in glutaraldehyde in 50 mM phosphate buffer (pH 7.2) and transferred into 50% ethanol. The samples were then dehydrated in an ethanol series of 60%, 70%, 80% for 30 min in each. The samples were mounted on stubs with conductive double-sided carbon tape and coated with gold/palladium in a sputter coater (Polaron SC7620, UK) for 90 sec at 9 mA. The samples were examined and photographed using a JEOL JSM 5500 scanning electron microscope (SEM) at an accelerating voltage of 5 kV.

Glochidial valve length was measured as the greatest distance from anterior to posterior margins parallel to the hinge. Glochidial valve height was measured as the greatest distance from dorsal to ventral margins perpendicular to the length.

RESULTS

Potomida littoralis (Cuvier, 1798)

Figs. 3, 5A, 6–11

The glochidia of *P. littoralis*, which are parasitic on the gills of freshwater fish, have no hooks. They are subelliptical, with a semicircu-

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[1] Mustafa Kemal University Faculty of Fisheries and Aquatic Sciences, 31200 İskenderun, Hatay, Turkey
[2] Department of Plant Protection, Mustafa Kemal University, 31034 Antakya, Hatay, Turkey
*Corresponding author: hovat@mku.edu.tr

TABLE 1. Some characteristics of unionacean glochidia.

	Shell colour	Shell form	Hooks	End of hook
Potomida littoralis	Lightly brownish	remarkably longer than high	no hooks with spines	
Anodonta pseudodopsis	cream-brown; sometimes cream coloured	slightly longer than high	medium-size (72–76), with numerous spines	pinched, triangular sharp
Unio terminalis	cream-brown usually whitish brown	slightly longer than high with prominent ventral apex	medium-size (31–33), with numerous spines	triangular sharp, pinched

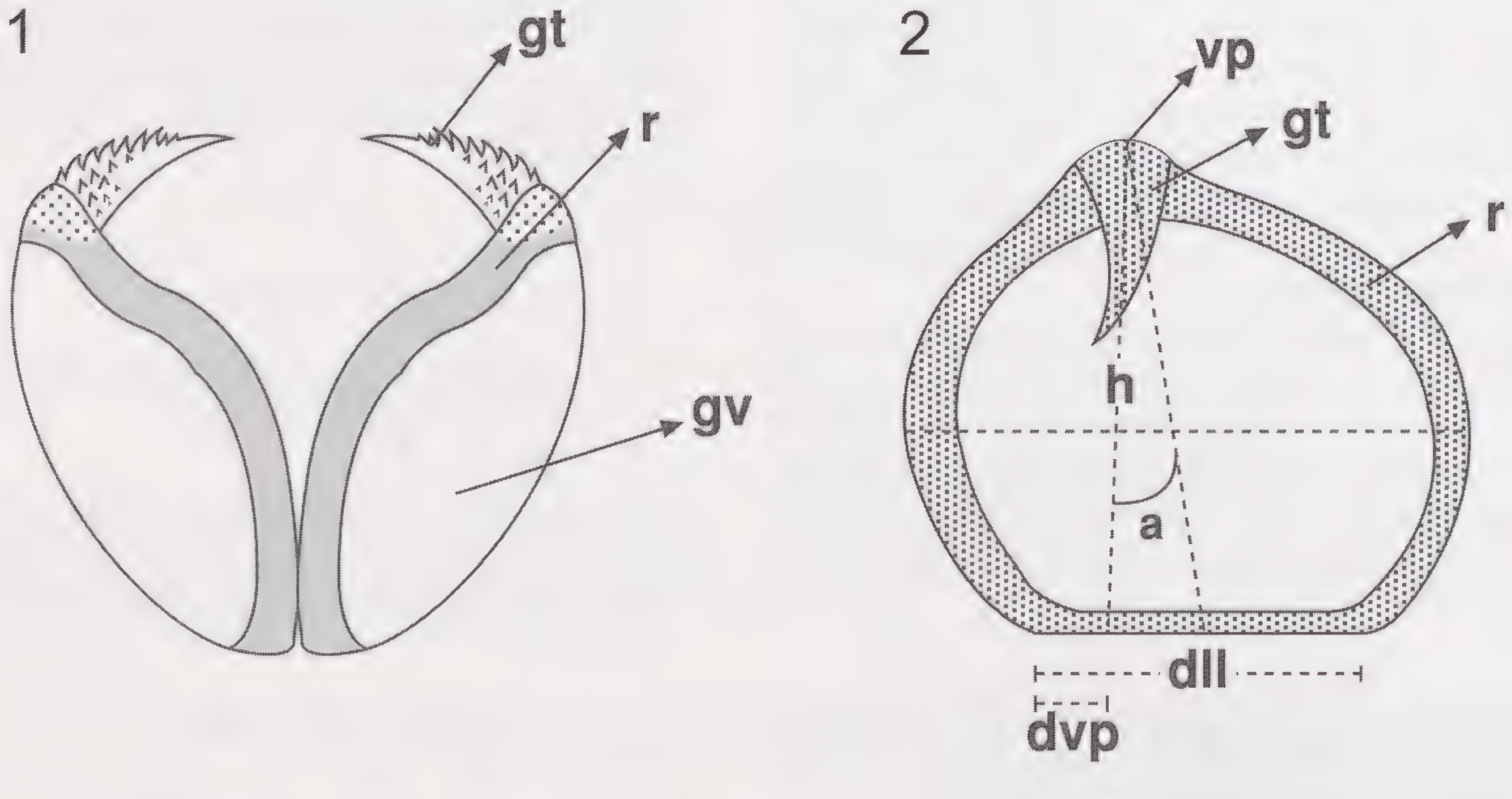
lar ventral margin. The lateral margins are subequal, with the anterior margin slightly thicker than the posterior. Lanceolate micropoints are located on the ventral rim of valve and on the narrow ventral flange, arranged in broken vertical rows covering most of the area of flange. These glochidia can be distinguished from other species in being more broadly rounded, with numerous micropoints.

Anodonta pseudodopsis Locard, 1883
Figs. 1, 2, 5B, 12–17

The glochidia of *A. pseudodopsis* are fin parasites. They are subtriangular and have a rounded anterior margin, which is smoother than the posterior. The posterior margin is gently curved throughout its length, producing a moderately asymmetric contour. Styli form a hook with biconcave lateral margins and a sharp tip. Hook styli form is covered with about 12 microstylets. Numerous micropoints cover the ventral terminus and lateral surface of the hook. The unsculptured distal tip has a tapered margin. The valves of the glochidia of *A. pseudodopsis* are usually a light coloured cream-brown.

Unio terminalis Bourguignat, 1852
Figs. 5C, 18–25

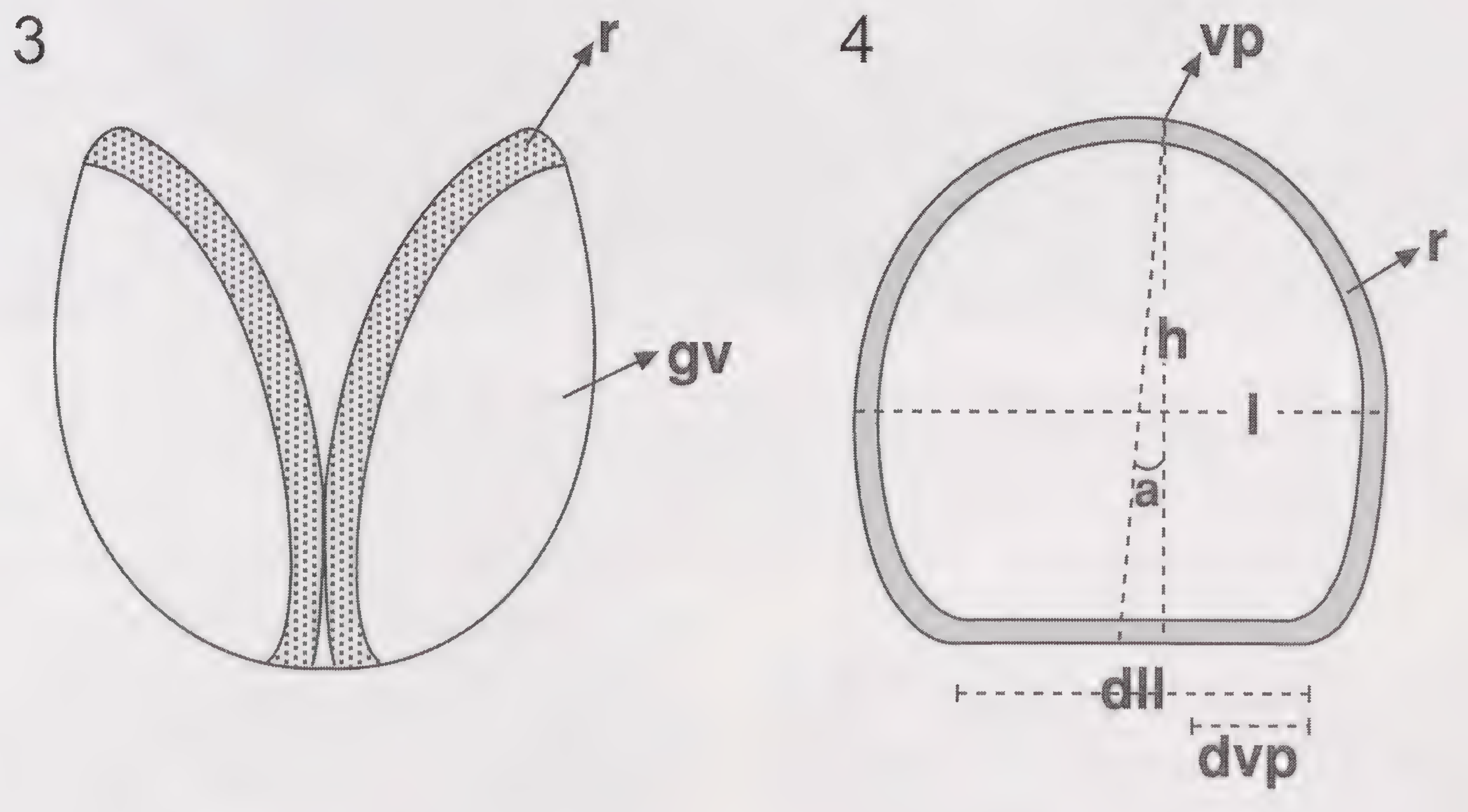
The glochidia of *U. terminalis* are fin parasites. They are subtriangular with a slightly asymmetric shape. A styliform hook extends from ventral terminus of each valve. The hooks are uniformly tapered. Most microstylets (about 30) are bluntly pointed, whereas some are more proximally multifaceted. Micropoints cover the lateral and proximal margins of the hook, except for a narrow distal band. The cream-brown valves of the glochidia are translucent.



FIGS. 1, 2. Glochidium of *Anodonta pseudodopsis*, with a hook-shaped teeth. FIG. 1: Frontal view, profile of teeth; FIG. 2: Glochidial valves in lateral view.

TABLE 2. Statistical data on glochidia. Abbreviation: DLL, Dorsal hinge length; DVP, Displacement of the ventral point in relation to the middle of the hinge lenght; A°, Angle of the ventral point in relation to the center of the hinge; GTL, Glochidial tooth length; GTH, Glochidial tooth height.

	Range	Mode	Mean	s	CV%
Potomida littoralis (Lamarck, 1801) N= 60					
Length	190–280	240	235	0.0081	2.97
Height	132–174	150	153	0.0093	6.72
DLL	122–146	130	134	0.0095	3.21
DVP	35–61	50	48	0.0072	20.26
A°	3°–10°	7°	6°	1.76	14.42
Anodonta pseudodopsis (Locard, 1883) N= 60					
Length	310–346	325	328	0.0112	2.46
Height	292–314	300	303	0.0077	2.37
DLL	230–291	250	260.5	0.0119	2.65
DVP	20–50	35	35	0.0085	21.31
A°	7°–17°	12°	12°	1.93	16.42
GTL	72–76	74	73	0.0092	3.69
GTH	21–27	24	24	0.0078	4.35
Unio terminalis (Lea, 1863) N= 60					
Length	193–247	220	220	0.0109	3.41
Height	175–196	180	185	0.0085	2.97
DLL	170–213	190	191	0.0105	4.32
DVP	35–68	50	51	0.0088	22.54
A°	6°–15°	11°	10°	1.89	16.93
GTL	31–33	32	32	0.0071	2.51
GTH	10–12	11	11	0.0055	2.13



FIGS. 3, 4. Glochidium of Potomida littoralis, unhooked glochidium type. FIG. 3: Frontal view; FIG. 4: In lateral view. Abbreviation: a – angle; am – adductor muscle; r – rim; l – length; dll – dorsal hinge; dvp – displacement of the ventral point in relation to the middle of the hinge; gb – growth band; gt – glochidial tooth; gv – glochidial valve; h – height; vp – ventral point.

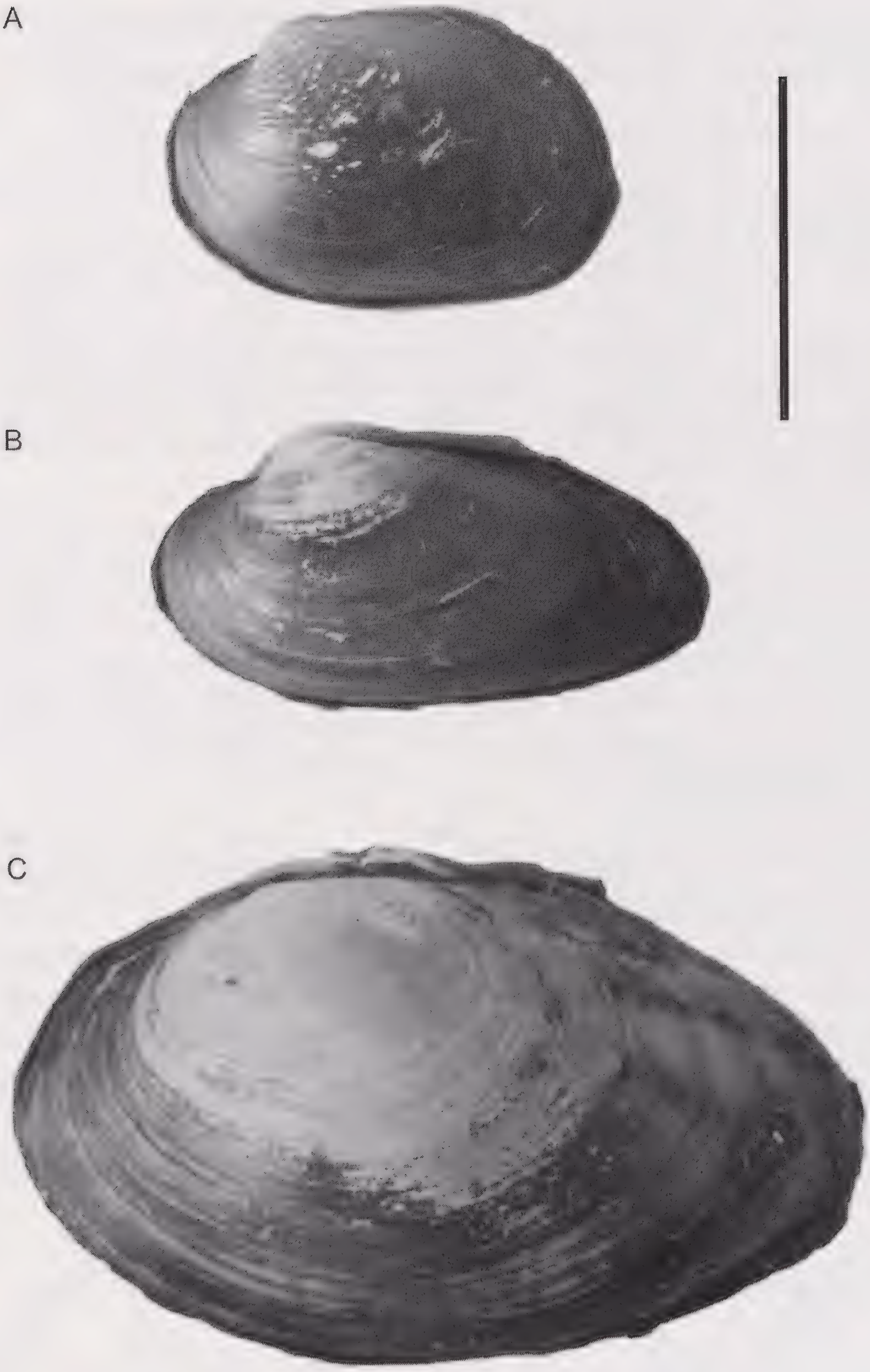


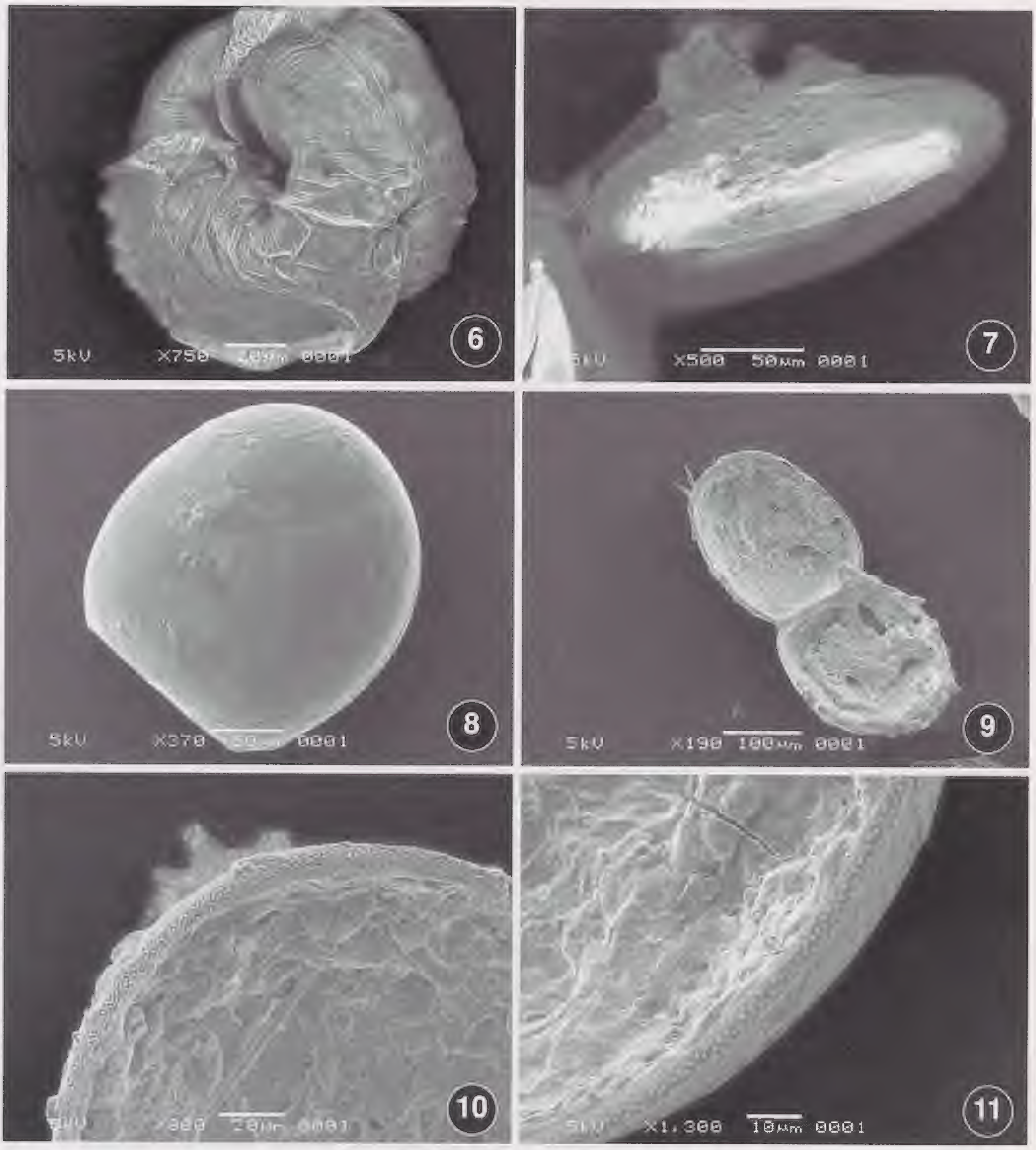
FIG. 5. Shells of the adult freshwater mussels. A: *Potomida littoralis*; B: *Unio terminalis*; C: *Anodonta pseudodopsis* (scale bar = 5 cm).

DISCUSSION

Freshwater mussels spend some time as larval stage parasites on freshwater fishes. Hooked glochidia may attach themselves to the body surface, gills, or fins. Hookless glochidia are usually encysted on fish gills (Arey, 1924; Wächtler et al., 2001). Unhooked-type glochidia are observed in the Unionoidae, including *Potomida* (Graf & Cummings, 2006).

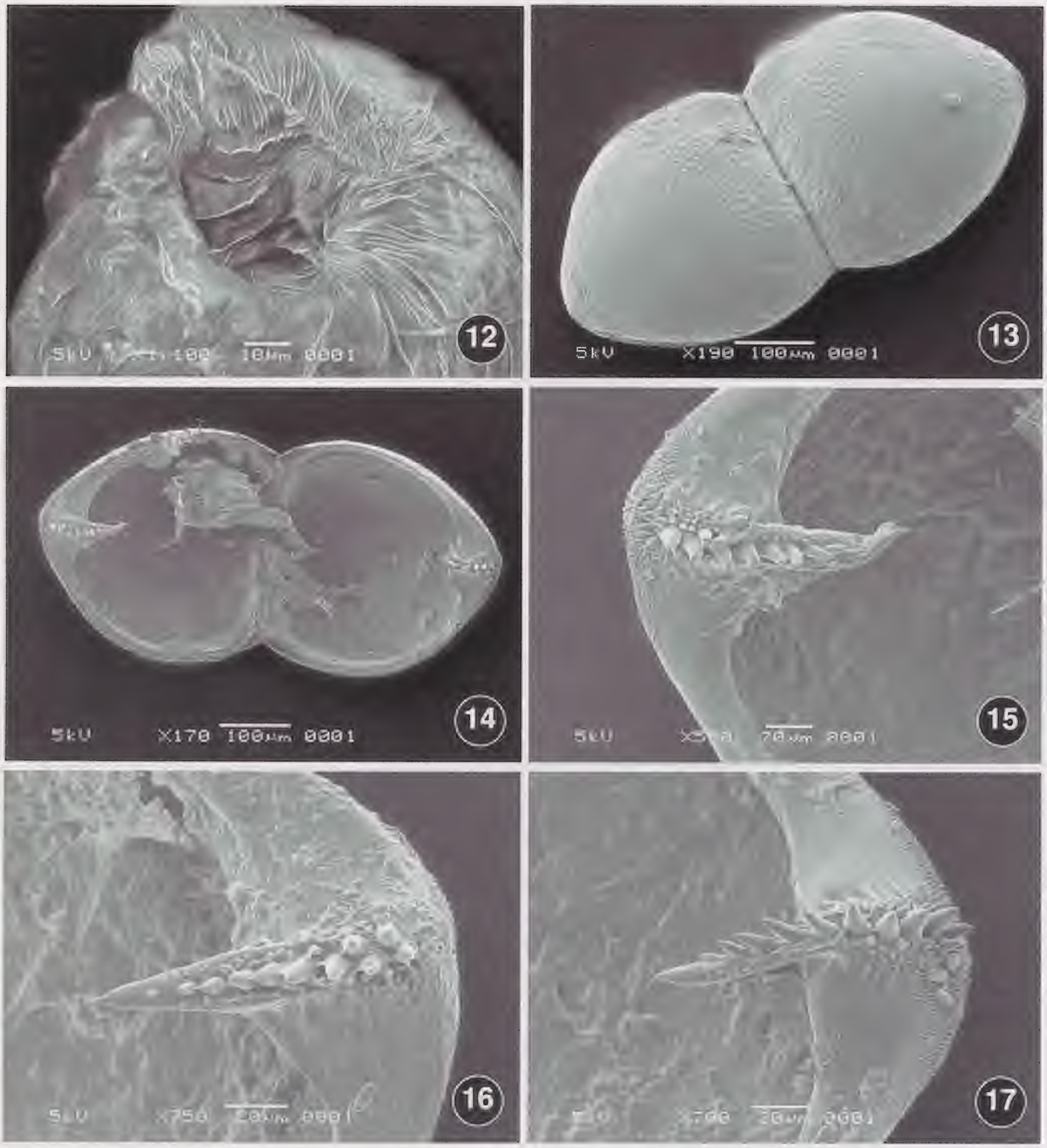
In this study, *P. littoralis* was identified by its subelliptical shape (length 190–280 µm, height 132–174 µm). It is very thin. In Europe, hookless but denticulate glochidia include at least those of *P. littoralis*, according to Giusti (1973).

The glochidia of *A. pseudodopsis* can be distinguished from those of *Unio* by their shape, hook structure, exterior valve sculpturing, and size. The dimensions of the larva of *A.*



FIGS. 6–11. Scanning electron microscopy of the glochidia of *Potomida littoralis* in the marsupium. FIG. 6: The shell pellicle is saddle shaped; FIG. 7: Differentiation of the shell from late gastrula to glochidia; FIG. 8: Surface views of *P. littoralis*; FIG. 9: Inside views of opened *P. littoralis* glochidia; FIGS. 10, 11: Numerous bluntly pointed micropoints present on valve margin.

pseudodopsis ranged from 310 µm to 346 µm in length. They resemble those of *A. cygnea* (Linnaeus, 1758) – 0.31–0.43 mm (Claes, 1987; Niemeyer, 1992) – in shape and size, but have no other characters of that species. The *A. pseudodopsis* glochidia different from those of *A. anatina* (Linnaeus, 1758) – 0.34–0.36 mm (Niemeyer, 1992), *A. beringiana* (Middendorff, 1851) – 0.28–0.29 (Hoggarth, 1999), *Pseudoanodonta complanata* (Rossmässler, 1835) – 0.29–0.34 mm (Hüby, 1988; Kinzelbach & Nagel, 1986), and other species of the Anodontinae in view of their numerous microstylets and micropoints. The glochidia of *A. pseudodopsis*

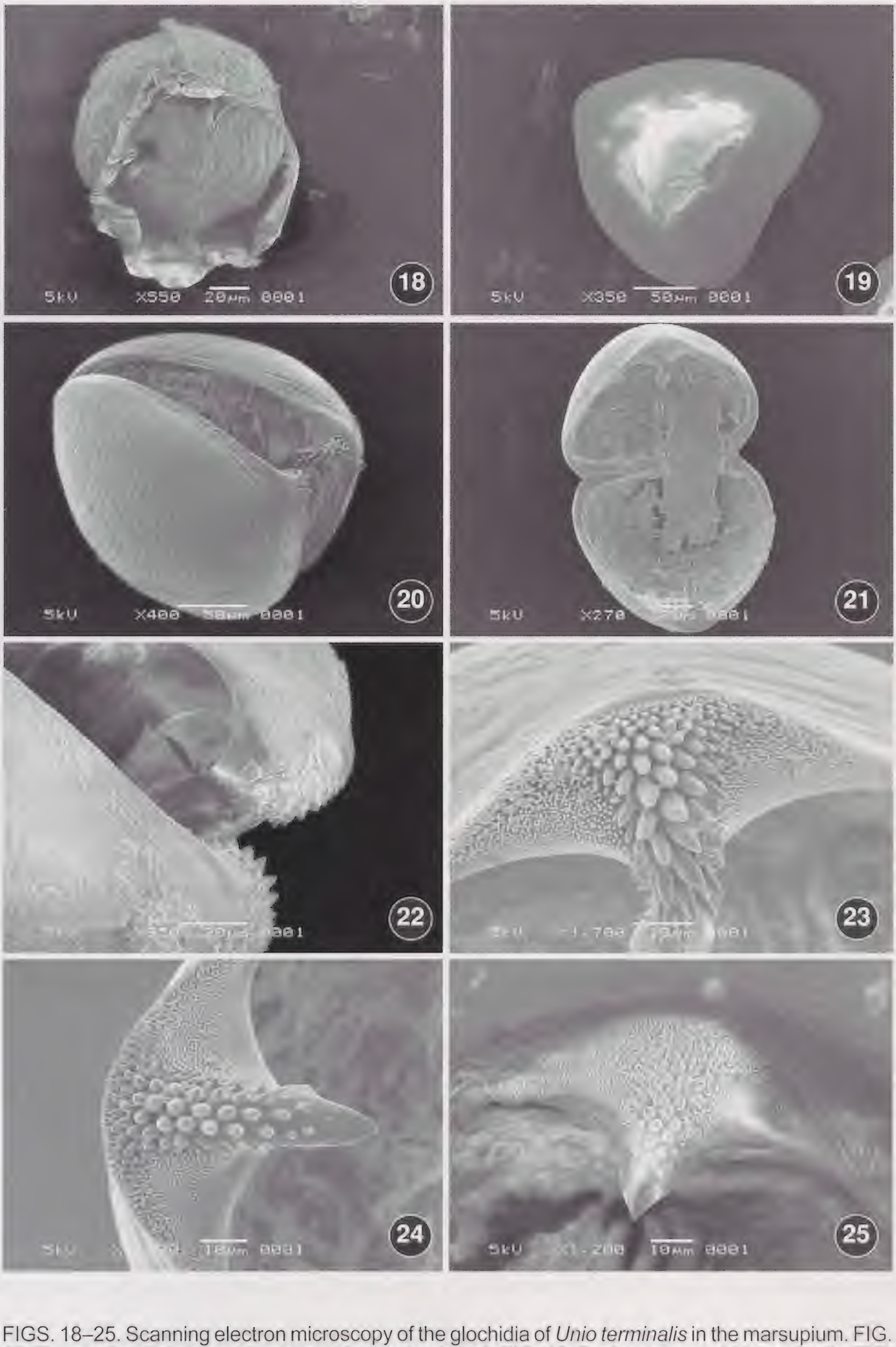


FIGS. 12–17. Scanning electron microscopy of the glochidia of *Anodonta pseudodopsis* in the marsupium. FIG. 12: The shell-pellicle is saddle shaped (gastrula phase); FIG. 13: Surface views of *A. pseudodopsis*; FIG. 14: Inside views of opened *A. pseudodopsis* glochidia; FIGS. 15–17: Styliform hook (about 11 microstylets) of *A. pseudodopsis* glochidia.

were not previously figured.

The hook structure of *U. terminalis* differs from those of *U. tumidus* Retzius, 1788, and *U. pictorum* (Gmelin, 1791) not only in being tapered but also in the placement of microstylets on the hook. The glochidia of *U. terminalis* are darker than those of A. *pseudodopsis* and have a very long, pointed hook with several stylets of various lengths arranged in multiple rows. No previously published figure of this glochidium was found.

Examination of glochidia of additional species would provide information relevant for unionid taxonomy.



FIGS. 18–25. Scanning electron microscopy of the glochidia of *Unio terminalis* in the marsupium. FIG. 18: The shell pellicle is saddle shaped (gastrula phase); FIG. 19: Surface views of *U. terminalis*; FIG. 20: Lateral view; FIG. 21: Inside views of opened *U. terminalis* glochidia; FIG. 22: Early glochidial stage; FIGS. 23–25: Syliform hook with about 30 microstylets of *U. terminalis* glochidia.

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